The Sex Ratios of Monozygotic and Dizygotic Twins

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Fellman and Eriksson (2010) cited my suggestion that the sex ratio (proportion male) of monozygotic (MZ) twins is lower than that of dizygotic (DZ) twins (James 1975). Here I offer elaborations on and potential explanations for this.

Keywords: sex ratios, monozygotic twins, dizygotic twins

The Sex Ratio of Monozygotic Twins

It is well established that the placentation of MZ twins varies by the time of the division of the embryo (Bulmer, 1970). If that division occurs during the first week of pregnancy, the twins will be dichorionic. If the division occurs rather later, they will be monochorionic diamniotic. Finally, monochorionic monoamniotic twins arise from division of the embryo towards the end of the second week of pregnancy. Such twins are usually separate; however, incomplete division of the embryo at this stage sometimes gives rise to conjoined twins.

The MZ division of the embryo and the process of X-inactivation occur at roughly the same stage of embryonic development. Burn et al. (1986) reported a case of Duchenne muscular dystrophy (DMD) in one of a pair of MZ twin girls. So they hypothesized that some cases of MZ twinning are somehow caused by anomalous X-inactivation. If that were correct, then MZ twins would contain an excess of females. As noted above, I had offered an indirect estimate of the MZ twin sex ratio at .496 (James, 1975), a value that I later adjusted to .492 (James, 1986). The evidence relating to Burn's hypothesis is given in Table 1. To summarize, the sex ratio of MZ twin pairs declines with the age of the embryo at the time of division, consistent with the hypothesis that MZ twinning is somehow and sometimes associated with anomalous X-inactivation. However, though further cases of female MZ twins discordant for X-linked diseases have been reported (Abbadi et al., 1994; some of which are thought to be caused by anomalous X-inactivation), the exact relationship between anomalous X-inactivation and MZ twinning has not yet been elucidated. It has been claimed, first, that the relative timing of the two events does not support a causal relationship (Monteiro et al., 1998) and second, that a higher frequency of skewed X-inactivation does not occur in female MZ twin members than their mothers and singleton sisters (Watkiss et al., 1994). Nevertheless, the curious association between the sex ratio of MZ twins and the age of the embryo at division does seem to suggest that X-inactivation plays some role here.

The Sex Ratio of Dizygotic Twins

Women who produce DZ twins are, in a sense, a reproductive elite. It is established that they are taller and heavier than other mothers (e.g., Hoekstra et al., 2010). In conformity with the influential hypothesis of Trivers and Willard (1973), it has been shown that (as contrasted with the sibs of control singletons) the sibs of DZ twin pairs contain a slight but significant excess of males (Milham, 1980; Schutzenberger, 1950; Turpin & Schutzenberger, 1952). I offered grounds for suggesting also that this applied to the DZ twins themselves (James, 1986). In that note I proposed that this slight excess of sons was hormonally produced (by high maternal levels of oestrogen and/or testosterone). Since then, I have adduced very substantial quantities of data to support the hypothesis that parental (including maternal) hormone levels around the time of conception partially control the sexes of the offspring (e.g., James, 2004; 2006; 2008). If that were correct, it would be tempting to suggest that the well-established association between DZ twinning and maternal smoking (e.g., Hoekstra et al., 2010) is secondary to correlations of each with steroid hormone concentrations. These correlate independently with both DZ twinning and with sensation-seeking (Zuckermann, 1994) and, in particular, with the initiation of smoking (Bratberg et al., 2007). Thus, it is suggested that the association between DZ twinning and maternal smoking (rather than being directly causal) is occasioned by confounding by hormones.

To summarize, it is suggested that the low sex ratio of MZ twin pairs is apparently somehow associated

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Table 1

The Sexes, Sex Ratios and Their Standard Errors of Monozygotic Twin Pairs: Data of James (1980)

	Male	Female	Sex Ratio	Standard Error
Dichorionic	76	57	.571	.043
Monochorionic diamniotic	694	717	.492	.013
Monochorionic monoamniotic	126	177	.416	.028
Conjoined	22	74	.229	.043

with anomalous X-inactivation; and that the high sex ratio of DZ twin pairs is caused by high maternal concentrations of steroid hormones.

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